A Review Of
Alaska School District Cost Study

Prepared for the Alaska Legislative Budget and Audit Committee

By

Dr. Bradford H. Tuck
Institute of Social and Economic Research
University of Alaska Anchorage

January 29, 2004

SUMMARY OF CONCLUSIONS

The Alaska Legislature's Legislative Budget and Audit Committee asked the Institute of Social and Economic Research (ISER) at the University of Alaska Anchorage to review the *Alaska School District Cost Study*. The American Institutes for Research (AIR) prepared that study for the legislative committee.

The study was to provide a "geographic cost of education index" that the state could use to help equalize the purchasing power of educational dollars it allocates to school districts across Alaska. Costs of living can vary substantially in different areas of Alaska.

The study, in two volumes plus supplemental materials, was released in January 2003 and supplemented in February 2003. Also, in a response dated April 11, 2003, AIR answered a number of questions that had been raised about the study.

The committee asked ISER to focus specifically on the methodology AIR used and to address the following questions.

(A) Is the methodology used by AIR generally acceptable? Methodology is to be interpreted to include both the theoretical basis underlying the choice of the index number used and the methodology used in estimating the various components of the index.

(B) If the methodology is generally acceptable, is there anything unique to Alaska that makes the use of this methodology inappropriate in Alaska?

(C) If the AIR methodology is generally acceptable for use in Alaska, but is deficient in some respects, can elements of the methodology be adapted so that use of the general AIR methodology is appropriate in Alaska?

(D) Is an alternative general methodology necessary, and if so, what might it be?

Our conclusions are summarized below, and a more detailed analysis is provided in the accompanying report.

• ***The methodology reflected in the use of the Törnqvist Index Number is appropriate. However, we have a number of concerns about the way AIR estimated some of the specific components of the index.***

The index has properties that, from a theoretical standpoint, should provide a more accurate measure of relative education costs than would the alternative—a fixed market basket index .

AIR defined four major sub-components (or cost categories) of the index that account for almost all expenditures for current operations: personnel services, consisting of costs for administrators, teachers, and classified personnel; energy services; cost of goods—supplies, materials, and small capital items—and costs of travel.

• AIR's estimation of the teacher compensation component of the index raises several concerns—primarily that the methodology does not adequately address the issue of teacher turnover rates.

Teacher compensation is a major element in the index, and failure to account for teacher turnover probably imposes a downward bias on the teacher cost component of the index. We also note and discuss more technical aspects of model specification in the body of this report.

• AIR's estimation of energy requirements and related costs is flawed, in our judgment. What the documentation of the AIR report describes is not how the index is actually calculated.

Furthermore, the difference between actual energy costs and what the index indicates energy costs should be differs substantially for many school districts. In many cases, the magnitude of discrepancies between the actual and the estimated costs appears to be far too great to be addressed by adjusting the thermostat at night or other usage adjustments.

• AIR used just two items (paper and windows) as a basis for estimating the cost of goods component of the index. For most indexes, this would be an unusually small sample of items.

The decision to use two items was a judgment call. A better basis for determining a representative sample (and budget proportions) might be to do a detailed analysis of a small number of representative schools and districts. Alternative pricing methods might also be considered.

• We find discrepancies between what the AIR documentation states and the actual computation of components of the travel index.

In some instances, these discrepancies would bias the index downward—that is, reduce the ratio of travel costs between Anchorage and the district in question. While this is a relatively small element of the index, we do not think that it is correct.

• AIR's definition and measurement of budget categories may or may not be adequate. There is simply no way to tell from the study reports.

The basic issue is whether or not the measured shares accurately reflect expenditures. AIR excluded revenue funds from expenditures—and that exclusion may be valid, but it raises questions.

A REVIEW OF THE ALASKA SCHOOL DISTRICT COST STUDY

The Institute of Social and Economic Research (ISER) at the University of Alaska Anchorage has been asked by the Alaska Legislature's Legislative Budget and Audit Committee to review the study conducted by American Institutes for Research (AIR) entitled *Alaska School District Cost Study*, composed of two volumes plus supplemental materials. The study was released in January of 2003, with supplemental materials being provided in February of 2003. AIR also provided responses to a number of questions that were raised regarding the study in a response dated April 11, 2003. The study's broad purpose was to construct a "geographic cost of education index" (GCEI) that could be used to assist in equalizing the purchasing power of educational dollars allocated to school districts across Alaska.

ISER has been asked to review the published study, supporting materials, and data sets underlying the estimation of the index. ISER has not been asked to assess the accuracy of data compiled by AIR. After review of the materials ISER has been asked to respond to the following questions.

(A) Is the methodology used by AIR generally acceptable? Methodology is to be interpreted to include both the theoretical basis underlying the choice of the index number used and the methodology utilized in estimating the various components of the index.

(B) If the methodology is generally acceptable, is there anything unique to Alaska that makes the use of this methodology inappropriate in Alaska?

(C) If the methodology utilized by AIR is generally acceptable for use in Alaska, but is deficient in some respects, can elements of the methodology be adapted so that use of the general AIR methodology is appropriate in Alaska?

(D) Is an alternative general methodology necessary, and if so, what might it be?

This report is divided into several sections. The first considers the theoretical basis for selecting the index number concept utilized by AIR. The second section reviews methodology used by AIR to estimate (calculate) the index. Each of the four major categories of the index (personnel services; energy services; supplies, materials, and small capital items; and travel) is analyzed. Based on the findings of these two sections the specified questions are addressed.

REVIEW OF THE THEORETICAL BASIS FOR SELECTION OF THE TÖRNQVIST INDEX.

From a theoretical basis, the choice of an index number depends on what is to be measured. In essence, the AIR contract statement of work asked AIR to derive measures of geographic cost differentials that are to be used in the calculation of K-12 school funding (similar to those currently found in AS 14.17.450). The stated objective for these measures is to "equalize the spending power of education funding in school districts throughout Alaska". It is also important to note that AIR was specifically instructed to not consider quality of education and school size factor adjustments.

The objective of equalizing spending power is open to several interpretations. The first is that a unit of equalized spending power enables each district to purchase a unit of education output of homogeneous (uniform) quality. A second interpretation is that the receiving district is able to purchase a unit of education output, but not necessarily of a quality comparable to some other district. A third interpretation is that each district is able to purchase a "unit," or some specified set of educational inputs. A final interpretation is that the recipient is able to purchase a collection of inputs that enables it to provide an equivalent unit of educational service (which may or may not equate to a unit of output).

In other words, does equivalence relate to purchase (cost) of output or inputs? These are two fundamentally different issues. In view of the contract language it appears that the Legislative Budget and Audit Committee wanted equivalence with respect to inputs. This interpretation is also reflected in the methodology AIR used.

Once the focus is on inputs, an additional question arises. By equivalence, is it meant that each district is provided with funding that enables it to purchase a specific set (market basket) of inputs, or that the district can purchase some set of inputs that enables it to provide an equivalent unit of educational service? This is the question that is central to AIR's discussion of the fixed market basket versus the so-called superlative index.

To see the significance of these distinctions, consider the nature of the problem that is faced. For the sake of simplicity, assume that there are two school districts. Each district has a "production function" that links a set of inputs (like teachers, staff, physical facilities, or others) to the "production" of education, measured as "output." The production of education entails the costs of purchasing the inputs represented in the production function. The relationship between the total cost of producing the output and the quantity of output is referred to as the total cost function. We can also think of the average total cost function, or cost per unit of output, as the function that reflects total cost of output divided by the amount of output. Suppose further that each district faces a different production function, that the input mix in each district is different, that the "outputs" of the districts differ qualitatively, and that the districts face different relative

prices for their inputs. This is the basic situation in Alaska and the task that the measurement of regional cost differentials must address.

Given these conditions we would expect to observe a number of differences among districts regarding the "production" or delivery of educational services. We would certainly expect the "average cost" of a unit of service to differ among districts, reflecting regional differences in the absolute cost of education inputs. We would also expect districts to organize "production" to reflect differences in relative prices between regions. This is the so-called "substitution effect." Inputs with relatively lower prices will be substituted for higher priced inputs, to the extent that substitution is possible. Thus, the proportion of a district's total budget spent on a particular type of input (e.g., administration, teachers with special certification or subject area expertise) will vary across districts in response to different relative prices.

Data reflecting budget shares spent on the major components of education inputs for Alaska districts do in fact reflect the substitution phenomenon and per student costs clearly vary across districts. It should be noted that variation in per student costs reflect both economic conditions (scale economies and regional differences in costs of inputs) and past policies regarding the level of state funding support to the districts. However, differences in input proportions (i.e., relative budget shares) are expected to primarily reflect economic factors.

These observations suggest that an index number used to measure differences in regional costs should be able to incorporate the consequences of the substitution effect. A fixed weight market basket index (where each district purchases the same set of inputs with the same relative quantities) does not do this.

AIR, Inc. has elected to use an index called the Törnqvist index. This is a geometric mean relative price index weighted (in this application) by the average of the budget shares of the two districts being compared (Anchorage and another district). We have reviewed a number of references in the literature regarding this index, including several of those cited in the AIR study. The Törnqvist index is used in a variety of contexts and the U.S. Department of Labor (Bureau of Labor Statistics) is utilizing it. The index does, in fact, appropriately adjust for the substitution effect.

REVIEW OF AIR'S ESTIMATION OF THE INDEX

The next part of this analysis reviews AIR's application of the index and the measurement of index components. The AIR materials that are part of the review include Volume I – Summary of Results, Volume II – The Technical Report, including appendices, and the index update ACCESS model and supporting documentation (Alaska School District Cost Study: Updating the Geographic Cost of Education Index Using Access). AIR has also provided several data sets that were used in their analysis. These have greatly facilitated our review. Where possible, we have reviewed the ACCESS model and attempted to replicate specific segments of the index number calculations.

AIR has identified four major categories of the index (personnel services; energy services; supplies, materials, and small capital items; and travel). These categories (as defined by AIR) account for almost all expenditures in the operating budget. Before reviewing individual components of the index a brief description of the index is given.

As stated above, the index is a geometric mean of price relatives, weighted by the average of the budget shares of the two districts being compared. A "price relative" is simply the price of an item in a specified district, divided by the price of the same item in the base (or reference) district, which is Anchorage. Thus, the basic steps in estimating the index involve estimating the "price" of each item included in the index for each of the 53 districts, and calculating the share of each district's budget that is spent on the category represented by the respective items.

The focus of the review is on the estimation of the various prices incorporated in the index, but we will also comment on the budget share question. A discussion of individual components of the index follows.

PERSONNEL SERVICES

The review of personnel services is drawn primarily from V.I, pages 7 – 9, V.II, pages 10 – 22, and Appendixes C – E.

The personnel services component of the index accounts for the largest share of budget expenditures, and is made up of three sub-categories (administrators, teachers, and classified employees). AIR uses hedonic wage models to estimate compensation (i.e., the price) in each of the three personnel components. Each of the estimating equations utilizes four sub-groups of independent variables to "explain" compensation; characteristics or attributes of the employee, characteristics of the school, regional amenities, and regional economic characteristics. The primary economic variable is the so-called comparable wage index. The index is discussed in Volume II, pages III-11 to III-16. This is an index that is intended to measure the relative comparable average wage level of twenty-seven Alaska labor market areas. The index is represented as measuring the relative cost of living in each of the 27 areas. This index is then used as one of the economic variables in the regression equations that estimate compensation.

The use of hedonic wage models is an established, and accepted, methodology. However, we have concerns regarding the present application. The first concern relates to the estimation and interpretation of the comparative wage index, and impacts on all three of the compensation model regressions. The second area of concern relates to the specification and estimation of the individual regressions.

As indicated above, the comparative wage index is presented as a measure of cost of living differences across the 27 labor market regions of Alaska, and as a measure of the comparative average cost of labor across regions. Data used to compute the index were provided by the Alaska Department of Labor and reflect average quarterly earnings by occupational classification code for each of the 27 labor market areas.

There are a number of assumptions that underlie this model that may or may not be met in the present application. AIR controls for variation in the occupational mix of employment, but as AIR points out, the available data do not ensure that the comparability of labor in different labor market areas is consistent. AIR notes that working conditions or regional amenities may influence comparability and wage rates, but that these factors are not separated out in the construction of the index. Other factors that may influence the index could include regional differences in the level of employment (e.g., hours worked per year), the rate of unemployment, or the labor force participation rate of a particular region. Differences in personal tastes and preferences may also be significant.

It is expected that average earnings or average hourly wages are also sensitive to the type of employer (i.e., industry), whether the employer is part of the private or public sector, and whether the mix of union and non-union employment for a given occupation is constant across areas. For large labor market areas there would be some tendency for these factors to average out, but for many of the Alaska labor market areas this is probably not the case. It should also be noted that the comparable wage index, if it is to measure the cost of living, is supposed to be based on wages by place of residence. As an index of the cost of employment, it should reflect wages by place of work. If significant commuting between labor market areas occurs, or if data are not correctly reported with respect to location, then potentially serious measurement error may occur.

More broadly, the comparative wage index is a measure of the cost of living only if fairly stringent assumptions are met. In addition to assumptions of comparability discussed above, comparability requires similar tastes and preferences among individuals, costless labor mobility, markets in equilibrium, and the absence of significant market power on the part of employers or employees. The index will not represent an accurate measure of the cost of living if there are other significant sources of income (including, for example, self employment, transfer payments, or subsistence).

Finally, the values of the index presented by AIR (Appendix C, page 74) contradict what most economists familiar with the Alaska economy would expect. The North Slope Borough has a value of 1.33 relative to Anchorage. One labor market area (Aleutians East) is equal to Anchorage, and all other labor market areas in the state (24) are lower than Anchorage. This clearly contradicts the food and energy market basket data compiled by the University of Alaska Cooperative Extension Service for several communities around the state. Alaska Department of Labor data for Alaska regional wages (based on survey data on hourly wages, as opposed to average quarterly or annual earnings) suggest that the pattern of average wages is mixed, with statewide averages exceeding Anchorage averages in some cases, while the opposite is also frequently the case.

In summary, the measurement and estimation of the comparable wage index raise several issues and bring into question the usefulness of the variable in the overall estimation or specification of the compensation model regressions. AIR has addressed some of the

concerns raised by inclusion of a measure of labor force participation, and by inclusion of some regional amenity measures. However, we do not think that it provides a reliable measure of either regional differences in the cost of labor or the cost of living. It is recognized that the variable is statistically significant in the regressions in which it is used, but this does not mean that the coefficient is reliably estimated. If there is measurement error in the variable then its coefficient and all of the other estimated coefficients in the regression are biased.

Use of the variable in the teacher equation is questionable. The variable is probably more likely to reflect labor market conditions for classified employees. The measurement errors discussed above are probably smallest if the index is used as an indicator of the cost of labor relative to classified employees. It should also be noted that the index is used in the calculation of the maintenance service call travel component. The index may be reasonable accurate for this use.

The second aspect of the estimation of compensation relates to specification of the equations. Specification relates both to the functional form of the equation and to the set of variables included in the equation.

The primary concern with the model selected for teacher compensation relates to teacher turnover. The problem of teacher retention (or turnover) in Alaska is often cited as one of the major problems facing public education in the state. The problem has been documented and analyzed in a study prepared for the Alaska Department of Education and Early Development by G. W. McDiarmid (University of Washington) and E. Larson and L. Hill (University of Alaska, ISER) in a December 2002 study entitled *Retaining Quality Teachers for Alaska.* Data in the study indicate wide variation in the turnover rate, ranging from a low of three percent to a high of fifty percent (average of 1996 – 2000). Rural districts tend to face the greatest retention problem.

AIR indicates that it tried a number of alternative models of teacher compensation. (See pages III-8 – III-20, Volume II). These included models where the housing benefit was excluded, where the index was constructed using data from earlier years, and another that specifically adjusted for teacher turnover. The report states that "Adjusting for turnover rates raises index values for all but five districts". The North Slope index was six percentage points higher than the model finally used. Exhibit E-1, page 84, provides a comparison between the index values used (Teacher regression: Salary & Benefits) and the turnover adjusted model (Teacher Tobit). Since turnover rates tend to be highest in rural (and remote) districts the index equation chosen tends to understate the difference between urban and rural school districts.

Furthermore, we do not think that simply using the AIR Teacher Turnover model resolves the problem. For reasons discussed below, there are specification and data measurement issues that need to be addressed.

Other concerns with the teacher regression relate to specification error. First, years of experience in a given district relates to salary level. If compensation is not high enough,

teachers leave. Generally, districts with higher turnover rates will have lower average experience levels. Thus, we could hypothesize that experience is a function of compensation, as well as compensation being a function of experience. In other words, experience is not an independent variable with respect to income, but this is what the AIR model specifies. This specification introduces an error in the estimation of the model (i.e., coefficients are not correctly estimated). This is another aspect of the turnover rate problem.

Another concern is that the data on salary do not reflect market clearing wages. In essence, for districts with large numbers of applicants relative to the number of positions, the quantity of teachers supplied exceeds the number demanded. This means that the wage paid is greater than the equilibrium, or market clearing, wage. If district "X" is in this market situation, while district "Y" with fewer applicants per position pays closer to market equilibrium, then the ratio of salaries of Y/X will understate the cost of comparable teachers between district Y and X. This understatement may reflect the difference in the cost of comparable teachers, or it may reflect an added difference in the form of higher quality of teachers as well as differences in cost.

A final concern relates to the omission of any real discussion of employer provided benefits. The text discussion of compensation does not address employer funded benefits, although Part VII of the survey instruments requests data on employee benefits. In the discussion of teacher compensation two measures are noted, salary, and salary plus benefits. However, the only difference between salary and salary plus benefits is the housing benefit. This is received in 227 of about 7000 cases. In other words salary is the same as salary plus benefits in almost all cases. Benefits that are not incorporated in the measure of compensation, but are received by all teachers, include employer contributions to retirement programs and health and welfare benefits. For teachers, the retirement benefit will be employer contributions to the Teachers Retirement System (TRS) and in some instances employer contributions to supplemental benefit systems (SBS). While the TRS contribution rate is the same for all districts (but may vary from year to year), the health and welfare benefits vary from district to district, and may be as important as the housing benefit in explaining teacher compensation.

Benefits do not appear to be included in the measurement of administrator or classified employees either. In these cases employees are covered under the Public Employees Retirement System (PERS). PERS contribution rates do vary from district to district and health and welfare benefits also vary across districts. This may be particularly significant in the case of administrators, where retirement benefits are heavily influenced by an individual's "high three" years of service. Benefits do appear to be included in the calculation of expenditure shares.

Whether the omission of benefits is a problem is an empirical question. The survey of districts did request benefit data for employees. It may be that variation in benefits is too small to be of significance. If this is the case it should be indicated. If benefits were not analyzed, this should also be indicated.

In summary, we think that the teacher model is mis-specified. While it may allow one to estimate the cost of a comparable teacher in two different districts, we think that the estimate is biased and that the difference in teacher cost is likely to be understated in many cases. The probable consequence of this misspecification is that the teacher index understates the true difference between Anchorage and many of the smaller rural or remote districts, and in particular those with high turnover rates.

COSTS OF ENERGY SERVICES

The review of the energy component of the index is based on a review of the following sections of the various reports; I, pp10-14; II, pp IV-23 – IV-32; Appendix F: Energy Prototypes, pp 89-93, as well as the energy services components of the ACCESS UPDATE MODEL.

AIR has chosen to estimate the cost of energy services using a two step process. First, an engineering model is used to develop estimates of energy consumption. The energy consumption model documentation states that the model relies on three prototypes reflecting three climate zones (moderate, cold, very cold). Prototypes for high school and elementary school facilities are also discussed. Subsequently, another prototype was identified as being needed to reflect distinct characteristics of rural schools (the K-12 prototype). The intent of these prototypes is to construct a "typical" or average facility for a given climatic characteristic. In the present case the heating degree day (HDD) measure is the single climate characteristic utilized. The assumed prototypes are then incorporated into a DOE 2.1 E model (which is never described or discussed) to generate energy consumption requirements.

The report states that energy requirements for school buildings are determined for space heating, hot water, electricity, cooking and swimming pool heating. Obviously, not all facilities will involve all end uses. District buildings and outbuilding energy requirements were estimated more simply. Two energy types were utilized (electric and fossil fuels) in the estimation of energy requirements. The energy requirements estimated are on a BTU per square foot basis. The energy requirement per square foot is then multiplied by the total square footage of a facility to obtain total BTUs for a specific end use.

The cost of energy requirements is obtained by multiplying the energy requirement (BTUs) by the price per BTU of the specific fuel type used for the given end use. Total end use cost is summed across end use types to get the estimate of total energy cost for a given facility. Facilities are then summed to the district level. This results in an estimate of total energy cost for the district.

The total energy cost for all facilities in a given district is divided by the total square footage of the district to obtain the district's energy cost per square foot. The ratio of this figure to the comparable Anchorage figure is the energy component of the overall index. There are a number of observations to be made regarding estimation of energy costs using this methodology.

This methodology estimates the hypothetical cost of energy for a facility of assumed physical characteristics and assumed usage. The only variables in the model are heating degree days and the price of energy, neither of which are under the control of the district. There is a significant "black box" aspect to the use of prototypes and a DOE Energy model. The model presumably tells us what energy consumption *should* be, given physical, operating and climatic characteristics related to the facility. While this modeling information might be useful in defining efficiency standards, it is not clear what its value is in measuring regional differences in energy costs. If the model projections and actual energy costs differ substantially it suggests that either the model does not work very well, or that the stock of existing facilities does not match the prototypes. If the model does not work well (i.e., is not a good predictor) then it should not be used. If it does work well, in the sense that predicted and actual costs are close, then what is the point of going to the trouble and expense of parameterizing the energy model?

To explore the significance of a prototype based energy cost index a rough calculation comparing actual and predicted energy costs has been made. Actual costs were taken from the study's *PART I: District Survey Fiscal Year 2002*, responses to question 1. The average of FY2000 and FY2001 has been used to reflect actual expenditures. Data from the energy section of the ACCESS model were used to replicate the calculation of the energy index. These data also provide the prototype-based estimate of energy costs by facility and by district. The comparison of actual and projected energy cost is done at the district level. A review of these cost estimates suggest that for many districts sizeable discrepancies exist between actual and prototype based estimates. On average (using the Mean Absolute Percent Error measure), there is a forty-two percent difference between actual and prototype-based estimates of energy costs.

The estimate of total energy cost will approximate the actual cost of energy only if the physical and use characteristics of the prototype and the existing facility are the similar. This certainly will not be expected in many instances. One would hypothesize that substantial variation in the physical characteristics of individual school facilities would exist, linked to age, design, construction and maintenance parameters. These variations most likely reflect a number of historical factors over which present administrators have had little control. In short, the stock of school facilities (and in particular, physical attributes) is essentially fixed in the short or intermediate term. The actual energy costs are real costs and are not subject to significant district administration adjustment in the near term. Data regarding the age and other characteristics of school facilities are not available to test this hypothesis, but the wide discrepancies between projected and actual energy costs is consistent with this hypothesis.

To the extent that actual and prototype facilities differ, and projected and actual costs differ, significant over- or under-funding of energy costs could result. It is not clear why AIR has chosen to ignore real costs of energy. This simply is not an area in which short-term policy adjustments can be expected to work. There are no policy variables for district administrators to utilize that will significantly alter energy costs in the short run. Alternatively stated, the short-run elasticity of demand for energy is highly inelastic.

Significant modifications to energy consumption need to be addressed through capital budgets, and not operating budgets.

In addition to questioning the use of prototypes, it does not appear that the set of prototypes described in the text of Volume II and appendices is what was used in the actual calculations in the ACCESS MODEL. For example, Exhibit IV-3 and Exhibit IV-4 (page IV-29, Volume II) indicate end use categories of space heat, hot water, cooking, swimming pool, and everything else. These exhibits also indicate three climate zones. It is not clear what these numbers reflect. The text indicates three physical facility prototypes (high school, elementary school, and rural K-12 school). Appendix F shows detailed assumptions regarding parameters related to the high school and elementary prototypes, but no K-12 parameters. Exhibits IV-3 and IV-4 make no distinctions between any of the three prototypes. Either the two (or three) prototypes have been merged somehow, or Exhibits IV-3 and IV-4 represent something else.

Finally, when reviewing the portion of the ACCESS model that calculates the energy requirements, it appears that only two climate categories are used (see ACCESS TABLE: ENERGY TERMS). Also, the same set of parameters used to calculate energy requirements for an elementary school are used to calculate the energy requirements for a high school (assuming the same fuel and climate type). There is also no distinction between parameters on an urban school and a rural K-12 facility (again assuming comparable climate and fuel type). In short, what is indicated in the text discussion of the model does not appear to be what is computed by the model. It might also be noted that the end use category “everything else” and space heat do not appear in the end use categories in the ACCESS model, but ”electricity,” and “school” do.

Other inconsistencies in the documentation could be cited. For example, on page IV-25 Kodiak is listed as a “cold” place. On page IV-26 (Exhibit IV-2) Kodiak is cited as an example of a “Moderate” climate zone. This does not inspire a lot of confidence in the underlying model. At best, this is sloppy documentation.

In summary, the energy costs portion of the index has been criticized on two bases. First, the use of a prototype driven energy requirements model does not reflect the decision making environment that a district administrator faces. The modeling process could be useful for design purposes and capital budget planning. However, it appears that historic energy costs would be a more relevant basis for calculating the energy portion of the index. Second, what is promised (or at least suggested) in the description of the calculation of energy costs via an energy requirements model does not appear to be what the access model actually does. This certainly raises questions about the viability and reliability of the prototype based energy index component.

COST OF GOODS

Our review covers V.I, pages 14 – 16, V.II, pages 33 – 39, and Appendix G.

The next component of the index is cost of goods. This component has two parts: office and instructional supplies, and small capital and maintenance supplies. Office and instructional supplies are represented by the average delivered cost of one case of paper. Small capital and maintenance supplies are represented by the delivered cost of one 4' by 5' windowpane, where delivery is to the school. Primary and secondary delivery modes were included. We understand how these items were selected. However, whether or not these are representative samples of purchases and related transportation costs needs more empirical verification. This could be done by limited, in depth sampling of selected schools and districts. An alternative method of measuring delivered pricing would also be appropriate. For example, this might be done by soliciting delivered price quotes from distributors and suppliers.

We have not examined the portion of the ACCESS Model that computes the goods portion of the index.

TRAVEL COSTS

The review of travel cost methodology includes V. I, pages 17-20, V.II, pages 40 – 49, Appendix H, and travel related components of the ACCESS Model.

This is a particularly poorly edited and documented portion of the report. As an example, in Volume I, page 18, it is stated that "Travel costs . . . were aggregated to the district level based on relative enrollment . . ." and "The three subcomponents of travel were aggregated into a single index for travel using the appropriate budget share weights described earlier." Elsewhere in the study it is stated (correctly) that full-time-teacher equivalents (not enrollment) is the weighting factor used and that there are six, not three, components to the travel index, as shown, for example, on page 121 of Volume II (Travel Index). Also, the exhibits referenced on page 18 (Vol. I), VII-2 and VII-3 are nowhere to be found (perhaps the authors meant VI-2 and VI-3). Exhibit VI-1 is never referenced.

As another example of poor editing and documentation, consider the Trip Index equation as shown on page 100 of Volume II and in the *Updating the SGCEI in Access Handbook*, page 8. The stated equation for calculating the index for remote (i.e., overnight stay required) is as follows.

$$\text{Trip Cost}_{ir} = \frac{\sum_j (schoolFTE)ijrX\,(roundtrip\,\text{cost}\,fromschooltodo)ijr + (450)ijr}{\sum (schoolFTE)ij}$$

As shown in the equation, the 450 dollar (per diem allowance for three days) term is not weighted by FTE. In the actual computations carried out by ACCESS, it is. Furthermore, the "overnight stay" cost factor varies in ACCESS, depending on the type of travel. When calculating PD1 (teacher professional development to the district office) the cost factor used appears to be $800. For teacher professional development travel to Anchorage (PD2), the figure is $450 (and for Anchorage teachers the figure is $75). The amount of

$450 is also used for administrators from schools to district office travel (PD3) and superintendents from district office to Anchorage (PD5). However, unlike the Anchorage teacher per diem of $75, the Anchorage superintendent per diem is $450. This has the effect of significantly decreasing PD5 relative to PD2, and one would expect the two to be roughly equivalent. Also, travel for school oversight (administrators from district offices to schools (SO1)) a figure of $84 is used. So far as we can tell, these distinctions are not shown anywhere in the reports or supplements. It is clear that the index values will be influenced by these distinctions. The Superintendent travel index will certainly be understated.

The other travel component is MT1 (maintenance or technical service travel), which is actually a measure of travel plus service, includes travel time in the calculation. When reviewing the ACCESS calculation of this index component it appears that only one-half of the total travel time is included (i.e., travel time to the job site). Return time is not included. If return trip travel time is included as part of normal billing practices, then this index component is understated for districts where maintenance and technical service travel time is significant.

In short, there are really six different formulas used by the model, and they are not what is shown in the documentation. The distinctions may be perfectly valid, but it certainly makes analysis of the travel components difficult.

BUDGET SHARE DETERMINATION

In addition to estimating prices of the index components, it is also necessary to establish relative budget shares. This involves a determination of what should, or should not, be included in total expenditures. The budget matrix presented in Exhibit I-1, page 112 includes both operating funds and special revenue funds. However, the text indicates that only operating funds were used in the determination of budget shares.

This raises two issues. First, on what basis are funds included or excluded from calculation of budget shares? This relates both to the decision to include only operating fund amounts and the assignment of specific fund amounts to specified expenditure categories. For example, if funds from special revenue funds go to pay for instruction that is included in the FTE Teacher count shouldn't those funds be part of the budget share? It is not apparent from the report as to how the budget share determinations were made, or by whom. As a general principle, if the availability of funding (from whatever sources) influences the quantity of an input purchased, then that funding should be included. We are not critical of the specific allocations represented, but do believe that the classification scheme should be more transparent.

Secondly, AIR has provided the budget data for each district, in the matrix format. We can replicate some elements of the budget shares table (Exhibit I-3, page 114), but not those related to administration, teaching and classified (and sometimes energy). While

the differences between what we calculate and what are shown in Exhibit I-3 are small they can have a significant effect in terms of actual dollars.

OTHER OBSERVATIONS

While not part of the methodology review, per se, it is impossible to ignore the quality of editing, documentation, and accuracy of the report. As pointed out in previous discussions there are numerous instances of inconsistencies, typographical errors, undocumented changes in variable names, and mismatches between what the text says the models are doing and what ACCESS actually computes. Overall, there is a real lack of continuity or cohesion in the discussion. This does not impugn the validity of the methodology, but it certainly makes it difficult to understand what the methodology actually reflects.

The ACCESS Model is of limited usefulness. There is no provision for changing the personnel components of the model, and yet this is by far the most important component of the index. The energy component can be updated for changes in energy prices or fuel type, but no other changes are allowed. Travel costs may be updated with respect to trip prices but per diem allowances cannot be updated without modifying the inner workings of the ACCESS model. In short, there are limited changes that can be incorporated without making modifications to the model itself.

It would also be a real help to potential users of the model if it were more adequately documented. There is no overall description or flowchart of the computational process. There is no description of the relation between the numerous table and query objects that are part of the model. Variables often are not defined, and may change in meaning from one query to the next. This makes it difficult for a user to understand or modify the workings of the model. This is particularly troublesome in view of the discrepancies between the text documentation and what the model actually does.

ISER also reviewed the responses to follow up questions regarding the study. Many of these relate to issues that have already been discussed. One area that has not been addressed is that of variations in specific elements of the index when making comparisons between districts (or in some cases, schools). Substantial variation, particularly in the smaller components of the index, can be expected. Extreme discrepancies need to be checked on a case by case basis. As AIR pointed out in its responses, there are usually legitimate explanations for observed differences. What should be of greater concern is significant differences in the overall index. We have made some cursory geographic comparisons but do not observe any systematic patterns of discrepancies.

IMPLICATIONS OF THE REVIEW

We turn now to the implications of the review and to address the specific questions addressed.

(A) Is the methodology used by AIR generally acceptable? Methodology is to be interpreted to include both the theoretical basis underlying the choice of the index number used and the methodology utilized in estimating the various components of the index.

As stated earlier, we think that the choice of index number type is appropriate and methodologically sound. We have raised a number of issues regarding measurement of components of the index. These are discussed below.

(B) If the methodology is generally acceptable, is there anything unique to Alaska that makes the use of this methodology inappropriate in Alaska?

The findings of our review do not suggest that there is anything unique about Alaska that makes the general methodology inappropriate for use in the state. As indicated above, there are problems in the measurement of index components. These may result from an incomplete understanding of Alaska, but do not invalidate the general methodology.

(C) If the methodology utilized by AIR is generally acceptable for use in Alaska, but is deficient in some respects, can elements of the methodology be adapted so that use of the general AIR methodology is appropriate in Alaska?

We have identified a number of problem areas regarding measurement of index components.

Estimation of teacher compensation needs to be modified. The compensation model needs to be re-specified to address issues raised regarding turnover, income/experience interdependence, and measurement errors in market prices for teachers.

The energy costs based on the prototype model are prone to significant error when compared to actual energy costs. We suggest that actual energy costs be used.

The travel cost component should be reviewed with respect to per diem allowances and the cost of travel time for maintenance/technician service call travel.

The cost of goods component may be satisfactory in the short run, but it needs additional validation. In particular, do paper and windows adequately represent expenditure patterns in this budget category? Secondly, alternative measures of delivered prices should be considered.

The definition and measurement of budget categories may or may not be adequate. There is simply now way to tell from the study reports. The basic issue is whether or not the measured shares accurately reflect expenditures. The exclusion of revenue funds from expenditures may be valid, but it raises questions.

(D) Is an alternative general methodology necessary, and if so, what might it be?

In our judgment the answer is no.

BIBLIOGRAPHY

Balk, Bert M., and W. Erwin Diewert, A Characterization of the Tornqvist Price Index. *Eonomics Letters* 72 (2001) 279-281.

Barnett, William A., Ki-Hong Choi, and Tara M. Sinclair, The Differential Approach to Superlative Index Number Theory. *Journal of Agricultural and Applied Economics, Supplement*, 35(2003):59-64.

Caves, Douglas W., Laurits R. Christensen, and W. Erwin Diewert, The Economic Theory of Index Numbers and the Measurement of Input, Output, and Productivity. *Econometrica*, Vol. 50, No. 6 (Nov., 1982), 1393-1414.

Chambers, Jay G., Geographic Variations in Public Schools' Costs, Working Paper No. 98-04, U. S. Department of Education, National Center for Education Statistics, 1998.

Chambers, Jay, Lori Taylor, Joe Robinson, *Alaska School District Cost Study: Volume I – Summary of Results*, American Institutes for Research, January 2003.

Chambers, Jay, Lori Taylor, Joe Robinson, *Alaska School District Cost Study: Volume II – The Technical Report*, American Institutes for Research, January 2003.

Robinson, Joe, and Gur Hoshen, *Alaska School District Cost Study: Updating the SGCEI in ACCESS Handbook*, American Institutes for Research, February 2003

Diewert W. E., Superlative Index Numbers and Consistency in Aggregation. *Econometrica*, Vol. 46, No. 4 (July, 1978), 883-900.

Diewert, W. Erwin, Productivity Measurement Using Differences Rather That Ratios: A Note, Discussion Paper, School of Economics, The University of New South Wales 2000/1.

Dumagan, Jesus C., Comparing the Superlative Tornqvist and Fisher Ideal Indexes. *Economics Letters* 76 (2002) 251-258.

Kokoski, Mary H., Brent R. Moulton, and Kimberly D. Zieschang, Interarea Price Comparisons for Heterogeneious Goods and Several Levels of Commodity Aggregation, Working Paper 291. U. S. Department of Labor, Bureau of Labor Statistics, September 1996.

Lent, Janice, A Note on the Effects of Extreme Price Values on Price Indexs. Bureau of Transportation Statistics and Bureau of Labor Statistics, 4/9/2003.

McDiarmid, G. W., Eric Larson, and Alexandra Hill, *Retaining Quality Teachers for Alaska*, Institute of Social and Economic Resdearch, University of Alaska Anchorage.

Pierce, Brooks, John Ruser, and Kimberly D. Zieschang, Constructing Interarea Compensation Cost Indexes With Data from Multiple Surveys, Working Paper 297. U. S. Department of Labor, Bureau of Labor Statistics, September 1996.

Reinsdorf, Marshall B., W. Erwin Diewert, and Christian Ehemann, Additive Decompositions for Fisher, Tornqvist and Geometric Mean Indexes, *Journal of Economic and Social Measurement* 28 (2002) 51-63.